Stenting for Left Subclavian Artery Stenosis before and after Coronary Artery Bypass Grafting Using the Internal Mammary Artery

A Report of Three Cases

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Summary

Stenosis of the subclavian artery proximal to the origin of the internal mammary artery (IMA) used for coronary artery bypass grafting may produce flow reversal (steal syndrome) and cause myocardial ischemia. We present three cases of subclavian artery stenosis proximal to the IMA before and after CABG. The first case developed symptomatic myocardial ischemia resulting from a variant of coronary-subclavian steal syndrome. The second case had asymptomatic subclavian artery stenosis proximal to the IMA used for CABG. In the third case we planned to perform CABG using the left IMA to treat cardiac ischemia. All of the patients were successfully treated by stent placement without the use of a protection device. In the first and second cases, cardiac ischemia did not appear during balloon inflation of the subclavian artery and no embolic complication occurred. In the third case, CABG was performed six months after stenting. Subclavian artery stenting is a valid alternative to surgical treatment to restore the flow to the IMA before or after CABG.

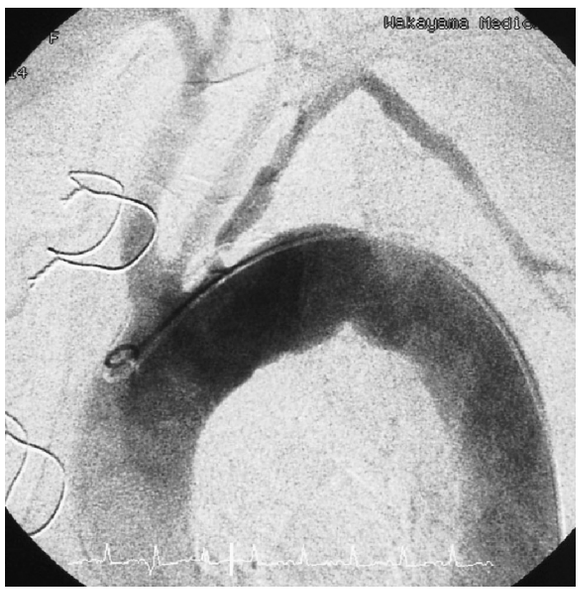
Introduction

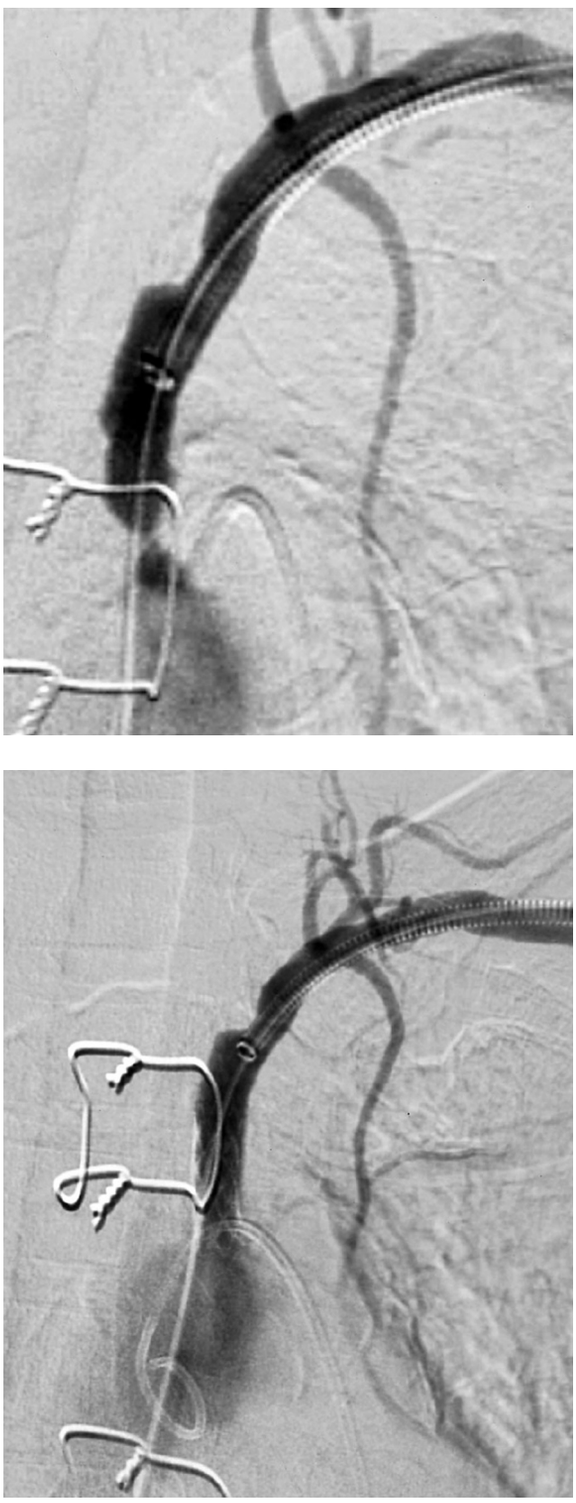
It is well known that patients with a coronary atherosclerotic stenosis often have other stenotic lesions. Occlusion of the subclavian artery may cause symptomatic cerebrovascular disease as well as arm claudication, weakness, and paresthesia related to arm exercise. When those patients treated with coronary artery bypass surgery using the internal mammary artery have an occlusive lesion in the subclavian artery, they may develop coronary ischemia. Proximal left subclavian artery stenosis can lead to reversal of flow in patients with left internal mammary artery to coronary artery bypass grafts resulting in myocardial angina.

We present three patients with subclavian artery stenosis in whom the internal mammary artery was used or was planned to be used as a coronary artery bypass graft. One of the patients developed symptomatic myocardial ischemia resulting from a variant of coronary-subclavian steal syndrome (CSSS), and the others had a severely stenotic subclavian artery with the possibility of causing myocardial ischemia. All of the patients were treated successfully by stent placement. We report our experience accumulated for prevention or treatment of CSSS.

Endovascular Technique and Case Presentations

Once the PTA/STENT was planned, all patients received 100 mg of aspirin and 200 mg of cilostazol or ticlopidine daily at least three days before the interventional treatment. All the procedures were performed under local anes-





thesia in the angio suite. Intravenous heparin was administered during the procedure to maintain an adequate activated clotting time between 250 and 350. In our institution, we introduced a 6-French or 7-French sheath into the left brachial artery. Under road-mapping, the lesion was crossed with a 0.035-inch angled guidewire. The lesion was predilated with an angioplasty balloon followed by deployment of a balloon expandable stent in all cases. Stent size was selected according to the diameter of the adjacent normal subclavian artery. Post-dilation was performed when a significant residual stenosis remained. Two kinds of antiplatelet agents were continued for at least three months after the procedure [6].

Case 1

A 74-year-old woman with a history of a coronary artery bypass grafting (CABG) was admitted to our hospital with recurrent angina after upper arm exercise stress. Aortography revealed severe stenosis (92%) of the left subclavian artery at the origin from the aortic arch and moderate stenosis (50%) at the proximal portion of the origin of the left vertebral artery (figure 1A). This symptom was felt to be related to poor bypass flow from the IMA. Subclavian artery stenosis was treated with percutaneous stenting to restore the coronary bypass flow from the IMA.

A 6-French arrow sheath was introduced into the left brachial artery using a conventional

Figure 1A,B Case 1. A) Coronary angiography revealed severe stenosis (92%) of the left subclavian artery at the origin from the aortic arch and mild stenosis (50%) at the proximal to the origin of left vertebral artery. IMA flow is poor and the flow direction of vertebral artery is anterograde. B) The origin from the aortic arch deployed by stenting.

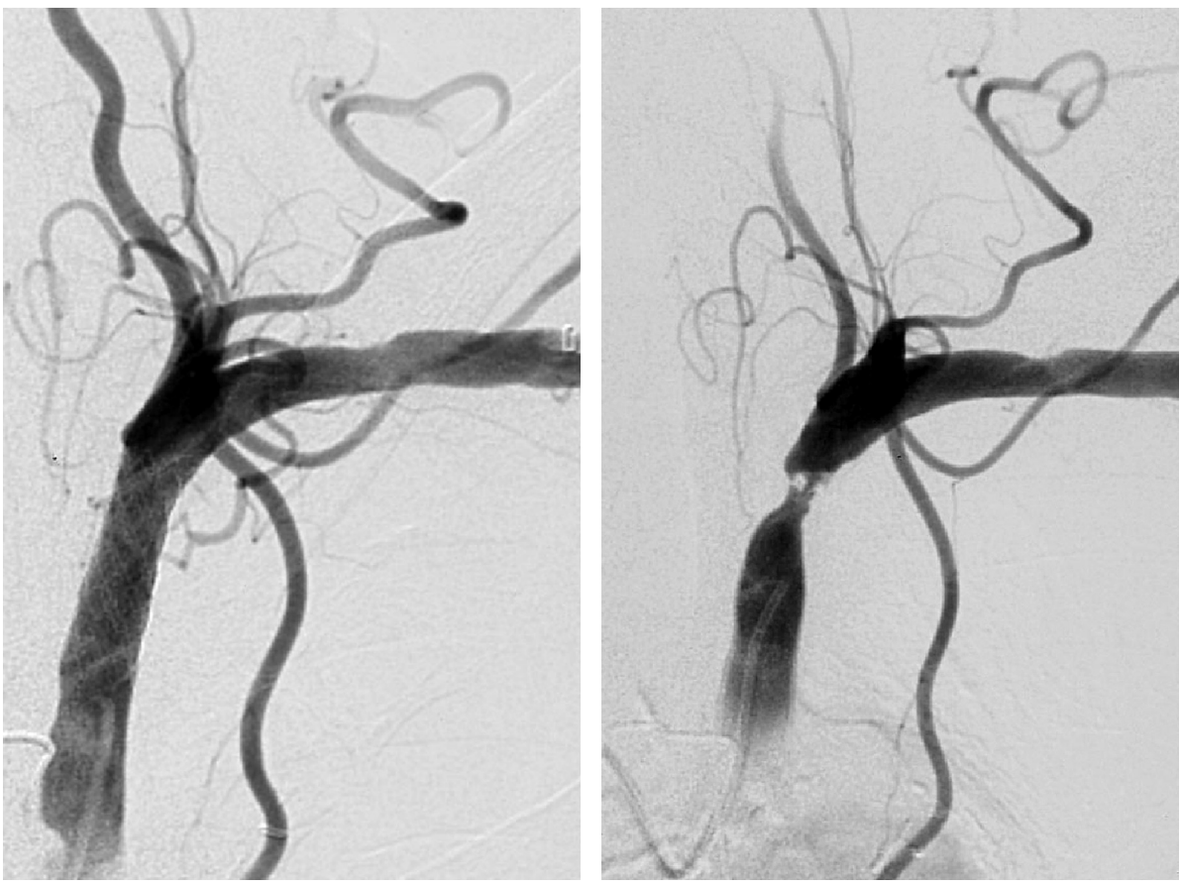


Figure 2 Case 2. Subclavian angiography showed severe stenosis (80%) and inadequate IMA flow. A 7 x 30 mm Palmaz stent was deployed to cover the entire lesion and the stent was further dilated with 8x20mm balloon catheter. After stent placement IMA flow increased.

method. A 0.035-inch guidewire was passed through the stenotic segment. A 6?20-mm Palmaz Stent (Optapro;Cordis Endovascular, Miami, FL) then was placed to cover the entire lesion. The stent was expanded fully and, as a result, angiographic LIMA flow was markedly improved (figure 1B). A distal protection device was not used. Coronary ischemic symptoms did not appear during stenting. The post treatment course was uneventful and the patient was discharged and asymptomatic with a normal physical activity. In the near future, the patient is going to be treated for supravaluvar stenosis.

Case 2

A 79-year-old man had undergone surgical revascularization using the LIMA to the distal LAD in 1998. He was noted to have a lower blood pressure in his left arm, so he was admitted to our hospital to be evaluated for left subclavian artery stenosis in 2005. Diagnostic subclavian angiography revealed patent bypass grafts but a critical stenosis of the left subclavian artery proximal to the origin of the IMA (figure 2A).

An interventional treatment was planned using stenting technique via a brachial approach. After a 7-French sheath was introduced into the left brachial artery, the lesion was crossed with a 0.014-inch guidewire (Transend, Boston Scientific, Massachusetts). The lesion was then dilated with an angioplasty balloon (Opta-5, Johnson and Johnson, Miami, FL), followed by deployment of a balloon expandable stent (Palmaz stent 7x30-mm) without distal protection. The stent was dilated further using an 8x20-mm PTA balloon at the proximal portion of the stent. Adequate flow through the LIMA and anterograde vertebral artery was restored. No

Figure 3 A,B Case 3. A) Subclavian angiography revealed severe stenosis (99%) of the left subclavian artery from the origin of the left subclavian artery to just proximal to the origin of the left vertebral artery and presented little anterograde flow and reversal of flow within the vertebral artery. B) Subclavian angiography showed anterograde flow of the left subclavian artery was adequate after stent placement.

coronary ischemic symptoms appeared during the procedure.

Case 3

A 63-year-old man was admitted for coronary artery bypass grafting for recurrent angina. Angiography revealed severe stenosis (99%) of the left subclavian artery from its origin to just proximal to the origin of the left vertebral artery and demonstrated little anterograde flow and reversal of flow within the vertebral artery (figure 3A).

A 6-French sheath was inserted into both the right femoral artery and the left brachial artery. A 6-French guiding catheter was placed at the orifice of the left subclavian artery and the tight stenosis was crossed using a 0.035-inch guidewire. The distal end of the guidewire was captured with a gooseneck snare wire and retrieved into the 6-French brachial sheath. A 0.018-inch/300-cm guidewire (SV wire; Cordis Endovascular, Miami, FL) was advanced through the 5-French catheter and introduced into the descending aorta.

The end of the guidewire was captured and retrieved into the 6-French femoral sheath. A

3.5-mm x 4-cm PTA balloon catheter (Savvy; Cordis Endovascular, Miami, FL) was navigated across the lesion over the SV wire and the lesion was dilated. A 6x40-mm Palmaz stent was deployed to cover the lesion. A 7.0 x 20-mm PTA balloon catheter (Powerflex; Cordis Endovascular, Miami, FL) was used to dilate the lesion further, resulting in successful opening of the left subclavian artery with anterograde filling of the left vertebral artery and LIMA. CABG using the IMA was performed six months after stenting for subclavian artery stenosis.

The results of stenting for subclavian stenosis are summarized in the table. After the procedure, the signs of myocardial ischemia subsided and normal neurological function recovered in Case 1, and LIMA flow was improved in Cases 2 and 3.

Discussion

Coronary subclavian steal syndrome was described first by Hargola and Valle [2] and Tyras and Barner [3] in the 1970s. In most cases, it is caused by the stenosis of the subclavian artery following atherosclerotic changes. The stenosis of the subclavian artery also causes hypoperfusion to the ipsilateral arm, with dullness, pain, functional impairment, reduction of radial pulse amplitude, and decreased blood pressure [4,5].

Proximal subclavian artery occlusion sometimes causes reversal of flow in the vertebral artery and symptoms of cerebral ischemia appear associated with upper limb exercise. Severe stenosis or total occlusion of the left subclavian artery may lead to myocardial ischemia when the patient has undergone LIMA bypass grafting to the coronary artery based on the same mechanism as subclavian steal syndrome. This rare phenomenon called CSSS is reported to occur in 0.4% to 1.1% of CABG patients [6]. Proximal stenotic lesions of the subclavian artery can cause reductions of flow within the left IMA graft and result in myocardial ischemia with or without reversal of flow within the vertebral artery. This syndrome is considered a variant of coronary subclavian steal [7]. One of our three patients presented with subclavian steal syndrome due to near occlusion of the proximal subclavian artery. On the other hand, in case 2, the flow in the left subclavian artery was anterograde. Therefore, it may be better to consider that they did not have coronary subclavian steal but a variant of coronary subclavian steal syndrome.

Our three cases were treated with stenting. Access to the subclavian lesion may be performed via the femoral or brachial route. We had a preference for the brachial approach, because it is easier to deploy the stent from this route.

Need for a protection device

Minimizing the risk of stroke during restoration of cerebral blood flow is a major consideration, and the possibility of thromboembolism during recanalization of an occluded subclavian artery is always a concern. It is believed that, even with maximal correction of the subclavian lesion, there is a substantial delay (20 s to more than 30 min) in the re-establishment of anterograde flow in the vertebral artery [8].

This delay protects the vertebral artery territory from thromboembolic complications by deflecting any emboli into the upper extremity rather than the posterior cerebral circulation. While it was not necessary to use a protective technique to prevent distal thromboembolism because there was retrograde flow in the vertebral artery in one case, the other cases may have needed protection of the vertebral artery. We performed stenting without any protection system being afraid of ischemia to the coronary artery by blocking the IMA. It may be effective to aspirate the debris using the aspiration catheter via the left brachial artery after stent placement.

Table

Case No.	Age(yr)/ gender	Symptoms	Pre/Post percent stenosis	Stent	Size (mm)	Distal protection	Complication
1	74/f	chest angina	92/0	Palmaz	6x20	(-)	(-)
2	79/m	asymptomatic	80/0	Palmaz	7x30	(-)	(-)
3	63/m	asymptomatic	99/0	Palmaz	6x40	(-)	(-)

Position and character of stent deployment

It is important to determine the position of stenting as well as the type and size of the stent. Generally we use balloon expandable stents for subclavian artery stenosis. The choice of self-expanding versus balloon-expandable stents depends on the angiographic characteristics. Self expanding stents are easier to deliver to the target lesions but are difficult to deploy at an exact position. On the other hand, balloon expandable stents offer more accurate deployment and stronger radial force. However it may sometimes be difficult to deliver a balloon expandable stent through a tortuous lesion[9]. Therefore, we prefer to use balloon expandable stents for the lesion where accurate positioning is necessary, such as ostial lesions or lesions close to the orifice of the vertebral artery.

Jean-Paul et Al[1] reported that percutaneous transluminal angioplasty of obstructive lesions in the proximal subclavian artery is not only an effective initial treatment, but is also successful over the long-term, with a five year primary clinical patency rate of 89%. Furthermore, all clinically significant recurrences of stenosis can be treated with repeat endovascular procedures. Bates et Al[10] reported that subclavian stent-supported angioplasty has a high primary success rate and an acceptable long-term patency rate.

Conclusions

Flow-limiting stenosis of the subclavian artery can be the cause of myocardial ischemia in patients treated with CABG using the internal mammary artery. Subclavian artery stenting has been proven to be a valid alternative to surgical treatment, achieving an optimal and immediate result for subclavian artery stenosis. This procedure can reduce cardiac ischemia and relieve angina.

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